Discussion of Arsenic Limits

The draft working fact sheet for PSNS&IMF (USEPA 2008) lists the standards applicable to human health, including Arsenic (As) as 0.14 ug/L inorganic As (see Table C - 4: Human Health for Consumption of Organism). Seafood including fish and shellfish contain relatively high amounts of As, but most of the As is present as organic As (e.g., arsenobetaine, arsenochloline, dimethylarsinic acid) and is "essentially nontoxic" (ASTDR 2007). In general, about 85-95% of the As in seafood is organic As and typically less than 10% is inorganic Arsenic (EPA 2003). The concentration of inorganic As in fish and shellfish from Sinclair and Dyes Inlet was evaluated by Johnson and Roose (2002). They found that inorganic arsenic comprised only 0.01% of total arsenic in English sole from Sinclair Inlet (Table 1) and ranged from 1.2 - 0.1% in clams and crabs from Sinclair and Dyes Inlets (Table 2). Ecology's 303(d) listing criterion for arsenic in edible fish and shellfish tissue is 0.006 ug/g wet weight, which is calculated using a bioconcentration factor of 44 L/Kg for inorganic As and the water column criterion 0.14 ug/L (Johnson and Roose 2002). Results from the study by Johnson and Roose (2002) showed that the listing criterion of 0.006 ug/g inorganic arsenic was exceeded in all clam samples analyzed. However, the authors concluded that "this appear[ed] to be due to natural conditions in Puget Sound. All crab and fish samples were at or below the listing criterion. It is therefore recommended that these waterbodies be taken off the 303(d) list for arsenic exceedances in edible tissue (12 listings in all)" (Johnson and Roose 2002).

Because the permit limit for As is based on total As, the As criterion needs to be adjusted for the amount of inorganic As present in seafood from Sinclair and Dyes Inlets. Using the maximum measured fraction of inorganic As in fish and crab of 0.1% reported by Johnson and Roose for crabs from Ostrich Bay (Table 2) the criterion becomes:

$$\text{Human Health Criterion} = 0.14 \text{ ug/L Inorganic As} \times \frac{1 \text{ Total As}}{0.001 \text{ Inorganic As}}$$

$$= 140 \text{ ug/L Total As}$$

Based on the Summary of Data Used to Determine Reasonable Potential Calculations Table 6-C, there is no reasonable potential that As would exceed the human health criterion.

Table 1. Results of arsenic and inorganic arsenic measured in fish samples from the Puget Sound (from Johnson and Roose 2002).

Table 3. Results of Battelle Marine Sciences Laboratory's Analysis of Total and Inorganic Arsenic in Archived WDFW Fish and Crab Composites [ug/g wet weight, parts per million]

Species and Location	Date Collected	No. of Individuals	Ecology Sample No.	Total Arsenic	Inorganic Arsenic		Percent Inorganic
English sole							
Sinclair Inlet	2000	15	98083	1.1	0.0013	NJ	0.1
Commencement Bay	2000	15	98084	1.2	0.0086	NJ	0.1
Elliott Bay	2000	15	98082	8.5	0.011	NJ	0.5
Hood Canal	2000	15	98083	1.1	0.035	NJ	0.1
Quillback rockfish							
Elliott Bay	1998	12	98081	0.89	0.011	NJ	1.2
Foulweather Bluff	1997	12	98085	2.4	0.032	NJ	1.3
E. Juan de Fuca Str.	2001	8	98086	2.0	0.013	NJ	0.7
Dungeness crab							
Hood Canal	2001	11	98087	5.0	0.025	NJ	0.5
Port Gardner	2001	11	98088	3.3	0.013	NJ	0.4
Commencement Bay	2001	12	98089	3.8	0.021	NJ	0.6
Coho salmon							
Skagit River	2000	12	98090	0.35	0.0062	NJ	1.2
Duwamish River	2000	12	98091	0.29	0.018	NJ	0.6
Nisqually River	2000	12	98092	0.31	0.0073	NJ	1.2
Pacific herring							
Cherry Point	2001	15	98093	0.98	0.00080	NJ	0.1
Port Orchard	2001	15	98094	1.8	0.0017	NJ	0.3
Squaxin Pass	2001	15	98095	2.0	0.0091	NJ	0.5

NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Table 2. Results of arsenic and inorganic arsenic measured in clams and crabs from Sinclair and Dyes Inlets (from Johnson and Roose 2002).

Table 5. Results of Brooks Rand's Analysis of Inorganic Arsenic in Clam and Crab Edible Tissue Composites: Total Arsenic Analysis by Ecology Manchester Laboratory [µg/g wet weight, parts per million]

Location	Species	Date Collected	No. of Individuals	Ecology Sample No.	Total Arsenic	Inorganic Arsenic	Percent Inorganic
Dyes Inlet							
Silverdale	Clam*	5/15/02	30	238-087	2.4	0.020	0.8
Ostrich Bay NW	Clam	4/13/02	31	238-084	3.2	0.017	0.5
Ostrich Bay W	Clam	4/13/02	35	238-085	4.2	0.018	0.4
Ostrich Bay SW	Clam	4/13/02	31	238-086	2.4	0.018	0.8
Ostrich Bay	Crab**	9/6/01	6	428-089	12	0.018	0.1
"	"	9/6/01	6	428-087	8.4	0.009	0.1
Oyster Bay	Clam	7/10/01	30	428-082	4.2	0.021	0.5
Port Washington Narrows							
Lions Park	Clam	7/10/01	30	238-091	2.2	0.015	0.7
Evergreen Park	Clam	8/31/01	20	428-085	1.9	0.022	1.2
Sinclair Inlet							
Port Orchard	Clam	5/1/02	30	238-088	2.8	0.025	0.9
Annapolis	Clam	5/1/02	30	238-083	2.3	0.022	1.0
Eagle Harbor							
Wing Point	Clam	4/28/02	30	238-082	3.1	0.021	0.7
Winslow Park	Clam	4/28/02	30	238-083	2.1	0.020	1.0
Hood Canal (reference area)							
Twanoh State Park	Clam	5/20/02	30	238-081	2.3	0.015	0.7
Sequim Bay (reference area)							
Sequim Bay State Park	Clam	4/29/02	30	238-080	3.4	0.035	1.0

* mixed native and Japanese littleneck clams

** graceful crab

References

ATSDR 2007. Agency for Toxic Substances and Disease Control, Toxicology Profile for Arsenic. Center for Disease Control, Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp2.html

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